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AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently amended) A method for compensating for time dispersion in a receiver of a wireless system that has a plurality of transmit antennas and a plurality of receive antennas, the method comprising the steps of:

receiving samples for each receive antenna;

determining a joint equalizer solution using channel information for at least one pairing of at least one of said transmit antennas and said receive antennas and said received samples of at least two of said receive antennas; and

applying said determined joint equalizer solution to said received samples from at least one of said receive antennas to develop equalized samples;

wherein said step of determining a joint equalizer solution is performed at least partly in the discrete frequency domain.

2. (Original) The invention as defined in claim 1 wherein said joint equalizer solution is a joint minimum mean square error (MMSE) solution.

3. (Currently amended) The invention as defined in claim 1 further comprising the step of estimating a channel for said at least one pairing of at least one of said transmit antennas and said receive antennas.

4. (canceled)

5. (canceled)

6. (canceled)

7. (Original) The invention as defined in claim 1 said step of applying said determined joint equalizer solution is performed in the frequency domain.

8. (Currently amended) A method for compensating for time dispersion in a receiver of a wireless system that has a plurality of transmit antennas and a plurality of receive antennas, the method comprising the steps of:

receiving samples for each receive antenna;

determining a joint equalizer solution using channel information for at least one pairing of at least one of said transmit antennas and said receive antennas and said received samples of at least two of said receive antennas;

applying said determined joint equalizer solution to said received samples from at least one of said receive antennas to develop equalized samples; and

~~The invention as defined in claim 1 further comprising the step of~~ despreading said equalized samples.

9. (Previously presented) The invention as defined in claim 1 wherein at least two of said transmit antennas transmit at different rates.

10. (Previously presented) The invention as defined in claim 1 wherein at least two of said transmit antennas transmit using different transmit constellations.

11. (Previously presented) The invention as defined in claim 1 further comprising the step of performing soft mapping using a version of said equalized samples.

12. (Original) The invention as defined in claim 11 wherein said version of said equalized samples are despread samples.

13. (Original) The invention as defined in claim 11 wherein said step of performing soft mapping further comprises the step of spatial whitening said version of said equalized samples.

14. (Original) The invention as defined in claim 11 wherein said step of performing soft mapping further comprises the step of performing a posteriori probability (APP) metric processing on said version of said equalized samples.

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15. (Original) The invention as defined in claim 1 wherein said determining step is performed multiple times, once for each one of said transmit antennas.

16. (Original) The invention as defined in claim 1 wherein said determining and applying steps are iterated multiple times over a symbol period, one iteration for each one of said transmit antennas, and said method further comprises, for each iteration, the steps of:

generating a representation of signals that would have arrived had a particular symbol for a currently being processed transmit antenna had been transmitted; and

subtracting said representation from said samples received for each receive antenna.

17. (Original) The invention as defined in claim 1 wherein said joint equalizer solution is one from the group consisting of: a joint least mean square (LMS) solution, a joint recursive least squares (RLS) solution, or a joint minimum intersymbol interference (ISI) subject to an anchor condition solution.

18. (Currently amended) A receiver for use in a multiple-input multiple-output (MIMO) system in which a plurality of signal detectors receive signals transmitted by a plurality of signal sources, said receiver comprising:

a joint equalizer that develops a joint equalizer solution using channel information for at least one pairing of ~~said~~ at least one of said signal sources and said signal detectors and received samples of at least two of said signal detectors and supplies as an output a signal that includes at least said <u>joint</u> equalizer solution applied to a signal received by at least one of said signal detectors; ~~and~~

a soft bit mapper for developing soft bits from said joint equalizer output<u>; and</u>

<u>a despreader interposed between said joint equalizer and said soft bit mapper</u>.

19. (Original) The invention as defined in claim 18 wherein said joint equalizer solution is a joint minimum mean square error (MMSE) equalizer solution

20. (Original) The invention as defined in claim 18 wherein said soft bit mapper further comprises an a posteriori probability (APP) metric processor.

21. (Original) The invention as defined in claim 18 wherein said soft bit mapper further comprises a spatial whitening unit.

22. (canceled)

23. (Original) The invention as defined in claim 18 wherein at least two of said transmit sources transmits signals at different rates.

24. (Original) The invention as defined in claim 18 wherein at least two of said transmit sources transmits signals using different transmit constellations.

25. (Original) The invention as defined in claim 18 further comprising:
a space time regenerator coupled to said joint equalizer; and
a buffer-subtractor coupled between said signal detectors and said joint equalizer and between said space time regenerator and said joint equalizer.

26. (Original) The invention as defined in claim 25 further comprising a front end processor coupled to said buffer-subtractor.

27. (Currently amended) The invention as defined in claim 18 further comprising
~~a soft bit mapper coupled to said joint equalizer;~~
an error correction decoder coupled to said soft bit mapper;
a space time regenerator coupled to said error correction decoder; and
a buffer-subtractor coupled between said signal detectors and said joint equalizer and between said space time regenerator and said joint equalizer.

28. (Original) The invention as defined in claim 27 further comprising a front end processor coupled to said buffer-subtractor.

29. (Original) The invention as defined in claim 18 further comprising an order controller for determining an order in which signals from said signal detectors will be processed by said joint equalizer.

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30. (Currently amended) ~~The invention as defined in claim 19~~ A receiver for use in a multiple-input multiple-output (MIMO) system in which a plurality of signal detectors receive signals transmitted by a plurality of signal sources, said receiver comprising:

a joint equalizer that develops a joint equalizer solution using channel information for at least one pairing of said at least one of said signal sources and said signal detectors and received samples of at least two of said signal detectors and supplies as an output a signal that includes at least said equalizer solution applied to a signal received by at least one of said signal detectors; and

a soft bit mapper for developing soft bits from said joint equalizer output;

wherein said joint equalizer solution is a joint minimum mean square error (MMSE) equalizer solution and wherein said join equalizer further comprises:

a first plurality of fast Fourier transform processors, each of said fast Fourier transform processors being coupled to receive a respective input corresponding to a signal received by one of said signal detectors and supplying as an output a discrete frequency domain representation thereof;

a plurality of channel estimation units each of which is coupled to receive a respective input corresponding to a signal received by one of said signal detectors which develops a channel estimate for each channel between each respective signal source and each respective signal detector;

a second plurality of fast Fourier transform processors, each of said second plurality of fast Fourier transform processors coupled to receive a respective input corresponding to a channel estimate for a respective one of said channels between said signal sources and said signal detectors and supplying as an output a discrete frequency domain representation thereof;

an MMSE detection per frequency bin processor coupled to receive as inputs said outputs from said first plurality of fast Fourier transform processors and from said second plurality of fast Fourier transform processors to produce a discrete frequency domain representation of an application of said joint minimum mean square error (MMSE) equalizer solution to said signals received by each of said signal detectors; and

a plurality of inverse fast Fourier transform processors which convert said discrete frequency domain representation of an application of said joint minimum mean square error (MMSE) equalizer solution to the time domain.

31. (Currently amended) The invention as defined in claim 30 wherein M is the number of signal sources and N is the number of signal detectors, and

wherein said MMSE detection per frequency <u>bin</u> processor performs the equalization in the frequency domain by computing

$$\mathbf{z}(\omega)=\left(\mathbf{H}(\omega)^{H}\,\mathbf{H}(\omega)+\sigma^{2}\mathbf{I}\right)^{-1}\mathbf{H}(\omega)^{H}\,\mathbf{r}(\omega)$$

where

$$\mathbf{H}(\omega)=\begin{bmatrix}\mathbf{h}_{1,1}(\omega) & \cdots & \mathbf{h}_{1,M}(\omega)\\ \vdots & \ddots & \vdots\\ \mathbf{h}_{N,1}(\omega) & \cdots & \mathbf{h}_{N,M}(\omega)\end{bmatrix}$$

$$\mathbf{r}(\omega)=\begin{bmatrix}r_1(\omega)\\ r_2(\omega)\\ \vdots\\ r_N(\omega)\end{bmatrix}$$

$$\sigma^{2}=\frac{\sigma_n^{2}}{\sigma_x^{2}}$$

σ_n^2 is the background noise plus interference power,

σ_x^2 is the sum of the power received by all said signal detectors from all of said signal sources,

each r(ω) is said output of a one of said first plurality of fast Fourier transform processors,

each **h**(ω) is said output of a one of said second plurality of fast Fourier transform processors,

I is the identity matrix,

$\mathbf{X}^{H}$ means the Hermitian transpose of **X**, which is the complex conjugate transpose of the vector or matrix **X**, and

z(ω) is the equalized output vector in the <u>discrete</u> frequency domain for frequency ω.

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32. (Currently amended) ~~The invention as defined in claim 19~~

A receiver for use in a multiple-input multiple-output (MIMO) system in which a plurality of signal detectors receive signals transmitted by a plurality of signal sources, said receiver comprising:

a joint equalizer that develops a joint equalizer solution using channel information for at least one pairing of said at least one of said signal sources and said signal detectors and received samples of at least two of said signal detectors and supplies as an output a signal that includes at least said equalizer solution applied to a signal received by at least one of said signal detectors; and

a soft bit mapper for developing soft bits from said joint equalizer output;

wherein said joint equalizer solution is a joint minimum mean square error (MMSE) equalizer solution and wherein said joint equalizer further comprises:

a plurality of channel estimation units each of which coupled to receive a respective input corresponding to a signal received by one of said signal detectors which develops a channel estimate for each channel between each respective signal source and each respective signal detector;

a plurality of fast Fourier transform processors, each of said plurality of fast Fourier transform processors being coupled to receive a respective input corresponding to a channel estimate for a respective one of said channels between said signal sources and said signal detectors and supplying as an output a discrete frequency domain representation thereof;

an MMSE tap weight calculator coupled to receive as inputs said outputs from said plurality of fast Fourier transform processors to produce a discrete frequency domain representation of a joint minimum mean square error (MMSE) equalizer solution to said signals received by each of said signal detectors;

a plurality of inverse fast Fourier transform processors which convert said discrete frequency domain representation of a joint minimum mean square error (MMSE) equalizer solution to matrices of filter coefficients in the time domain; and

a matrix finite impulse response (FIR) filter coupled to apply said matrices of filter coefficients in the time domain to said signals received by said signal detectors.

33. (Previously presented) The invention as defined in claim 32 wherein M is the number of signal sources and N is the number of signal detectors, and wherein said MMSE equalizer solution is developed by computing:

$$\mathbf{S}(\omega)=\left(\mathbf{H}(\omega)^{H}\mathbf{H}(\omega)+\sigma^{2}\mathbf{I}\right)^{-1}\mathbf{H}(\omega)^{H}$$

where

$$\mathbf{H}(\omega)=\begin{bmatrix}\mathbf{h}_{1,1}(\omega) & \cdots & \mathbf{h}_{1,M}(\omega)\\ \vdots & \ddots & \vdots\\ \mathbf{h}_{N,1}(\omega) & \cdots & \mathbf{h}_{N,M}(\omega)\end{bmatrix}$$

$$\sigma^{2}=\frac{\sigma_{n}^{2}}{\sigma_{s}^{2}}$$

σ_n^2 is the background noise plus interference power,

σ_s^2 is the sum of the power received by all said signal detectors from all of said signal sources,

each $\mathbf{h}(\omega)$ is said output of a one of said plurality of fast Fourier transform processors,

$\mathbf{I}$ is the identity matrix,

$\mathbf{X}^{\mathbf{H}}$ means the Hermitian transpose of $\mathbf{X}$, which is the complex conjugate transpose of the vector or matrix $\mathbf{X}$, and

$\mathbf{S}(\omega)$ is a frequency domain matrix representing the equalization for frequency ω.

34. (Currently amended) The invention as defined in claim 33 wherein said matrix FIR filter applies said matrices of filter coefficients in the time domain to said signals received by said signal detectors by computing

$$\mathbf{y}(k)=\sum_{j=0}^{F-1}\mathbf{S}_j\mathbf{r}(k-j)$$

where $\mathbf{y}(k)$ is ~~the~~ <u>a</u> vector output at time k, $\mathbf{y}$ having one component for each of said signal sources,

$\mathbf{S}_j$ is a MxN filter matrix for delay j, which is the inverse Fourier transform of $\mathbf{S}(\omega)$,

$\mathbf{r}(k)$ is a vector of received samples at time k, and

F is the number of samples taken for each fast Fourier transform by each of said plurality of fast Fourier transform processors.

35. (Original) The invention as defined in claim 18 wherein said MIMO system is a wireless system, said signal sources are transmit antennas and said detectors are antennas of said receiver.

36. (Original) The invention as defined in claim 18 wherein said joint equalizer develops said joint equalizer solution as a function of estimates of the channels between each of said signal sources and said signal detectors.

37. (Previously presented) The invention as defined in claim 18 wherein said joint equalizer develops and applies said joint equalizer solution in a time domain.

38. (Previously presented) The invention as defined in claim 18 wherein said joint equalizer develops and applies said joint equalizer solution in a frequency domain.

39. (Previously presented) The invention as defined in claim 19 wherein said joint equalizer develops and applies said joint equalizer solution in a discrete frequency domain and applies said joint minimum mean square error (MMSE) equalizer solution in a time domain.

40. (Previously presented) The invention as defined in claim 19 wherein said joint equalizer develops said joint minimum mean square error (MMSE) equalizer solution by computing

$$\mathbf{W} = \mathbf{A}\,\Gamma(\mathbf{H})^{H}\left(\Gamma(\mathbf{H})^{H}\,\Gamma(\mathbf{H}) + \frac{\sigma_n^2}{\sigma_x^2}\mathbf{R}_{pp}\right)^{-1}$$

where

$\Gamma(\mathbf{H})$ is a MIMO convolution operator,

$\mathbf{X}^{\mathrm{H}}$ means the Hermitian transpose of $\mathbf{X}$, which is the complex conjugate transpose of the vector or matrix $\mathbf{X}$,

$\mathbf{A}$ is a delay matrix ,

σ_n^2 is the background noise plus interference power,

σ_x^2 is the sum of the power received by all said signal detectors from all of said signal sources,

noise covariance $\mathbf{R}_{pp}$,

and said joint equalizer applies said joint minimum mean square error (MMSE) equalizer solution by computing

$$\mathbf{y}(k) = \mathbf{W}\mathbf{r}(k)$$

where $\mathbf{r}(k)$ is a vector of received samples at time k, and

$\mathbf{y}(k)$ is the vector output at time k representing the application of said joint minimum mean square error (MMSE) equalizer to said vector of received samples at time k.

41. (Original) The invention as defined in claim 18 wherein said joint equalizer solution is one from the group consisting of: a joint least mean square (LMS) solution, a joint recursive least squares (RLS) solution, or a joint minimum intersymbol interference (ISI) subject to an anchor condition solution.

42. (Currently amended) A receiver for use in a multiple-input multiple-output (MIMO) system in which a plurality of receive antennas receive signals transmitted by a plurality of transmit antennas, said receiver comprising:

means for (i) developing a joint equalizer solution using channel information for at least one pairing of at least one of said transmit antennas and said receive antennas and said received samples of at least two of said receive antennas, said joint equalizer solution being developed at least partly in a frequency domain, and (ii) supplying as an output a signal that includes at least said joint equalizer solution applied to a signal received by at least one of said receive antennas; and

means for developing soft bits from said output signal.